handwriting and computations of this intellectual giant, whose works will for all time be the greatest wonder to him who studies them the most.

With the hearty thanks of the section to Professor Adams for his exceedingly interesting communications, it was then adjourned.

PROCEEDINGS OF THE SECTION OF PHYSICS.

THE meeting of the American association was one of unusual interest and importance to the members of section B. This is to be attributed not only to the unusually large attendance of American physicists, but also to the presence of a number of distinguished members of the British association, who have contributed to the success of the meetings not only by presenting papers, but by entering freely into the discussions. In particular the section was fortunate in having the presence of Sir William Thomson, to whom more than to any one else we owe the successful operation of the great ocean cables, and who stands with Helmholtz first among living physicists. Whenever he entered any of the discussions, all were benefited by the clearness and suggestiveness of his remarks.

Among the members of the British association who were present, may also be mentioned Professor Fitzgerald of the University of Dublin, Professor Silvanus P. Thompson, Mr. W. H. Preece, superintendent of the English postal telegraph, Professor Forbes, and Professor Schuster of the Cavendish laboratory.

Among American physicists there were Professors Trowbridge, Rowland, Barker, Mendenhall, Hall, Hastings, Bell, Anthony, Brackett, Rogers, Pickering, Cross, and many others. The section was organized on Thursday, Sept. 4, and the opening address delivered by the vice-president, Professor Trowbridge. The time devoted to the reading and discussion of papers was unfortunately much infringed upon by the Electrical conference: yet, considering this serious interruption, the number of interesting discussions was unusually large.

It is not to be expected that the elaborate investigation of the relation of the yard to the metre, such as was the subject of a paper by Professor William A. Rogers, will be of very general interest. Yet to the physicist such a comparison, conducted by one who has had the long experience of Professor Rogers, is of the highest importance in giving accuracy to determinations of length. Professor Rogers has given his life to perfecting the construction and testing of standards of length, and the result of this his latest investigation is that the metre is 39.37027 inches in length. One of the most important physical measurements is that of the wave-length of light of any given degree of refrangibility, and this determination is best made by means of the diffraction grating. On account of the extensive use of the magnificent gratings constructed by Professor Rowland for this purpose, Professor Rogers instituted an investigation to determine the coefficient of expansion of the speculum-metal used in the construction of these gratings. He also noted that from its homogeneity, fineness of grain, and non-liability to tarnish, this speculum-metal is peculiarly suitable for constructing fine scales, though its extreme brittleness is an objection to its use for large scales. Professor Rowland stated that he proposed to construct scales on his ruling-engine which would enable the physicist at any time, by purely optical means, and without knowing the coefficient of expansion of the metal or its temperature, to obtain the value of the length of the scale in terms of the wave-length of any given ray of light. These scales were simply to be straight pieces of speculum-metal ruled with lines just as an ordinary grating, except that the length of the lines is to be only about one centimetre, every one-hundredth line being somewhat longer than its neighbors: the whole ruled strip is to be one decimetre in length. From the manner of ruling, it will be easy to count the whole number of lines in the length of the strip, and then by a simple use of the scale as a grating in a suitable spectrometer the whole length may be immediately found at any time in terms of any specified wave-length of light.

In some forms of telephones and in the microphone, the action depends on the change in resistance of a small carbon button on being subjected to pressure. There has been much discussion as to whether this diminution of the resistance with pressure is due to a change in the resistance of the carbon itself, or simply to the better contact made between the carbon and the metallic conductor when the pressure is applied. Professor Mendenhall has carried out some experiments to determine the question; and one of his methods of experimenting — that with the hard carbons — appears to point conclusively in favor of the theory that the resistance of the carbon itself is altered by pressure. The experiments made by him on soft carbon are open to criticism, though they also point to the change taking place *in* the carbon. Professor Mendenhall finds that the resistance is not simply proportional to the pressure, and thinks that by increasing the pressure a point of maximum conductivity would be reached where there would be no change in resistance for a small change in pressure.

Prof. A. Graham Bell, the inventor of the telephone, read a paper giving a possible method of communication between ships at sea. The simple experiment that illustrates the method which he proposed is as follows: Take a basin of water, introduce into it, at two widely separated points, the two terminals of a battery-circuit which contains an interrupter, making and breaking the circuit very rapidly. Now at two other points touch the water with the terminals of a circuit containing a telephone. A sound will be heard, except when the two telephone terminals touch the water at points where the potential is the same. In this way the equipotential lines can easily be picked out. Now, to apply this to the case of a ship at sea: Suppose one ship to be provided with a dynamo-machine generating a powerful current, and let one terminal enter the water at the prow of the ship, and the other be carefully insulated, except at its end, and be trailed behind

the ship, making connection with the sea at a considerable distance from the vessel; and suppose the current be rapidly made and broken by an interrupter: then the observer on a second vessel provided with similar terminal conductors to the first, but having a telephone instead of a dynamo, will be able to detect the presence of the other vessel even at a considerable distance; and by suitable modifications the direction of the other vessel may be found. This conception Professor Bell has actually tried on the Potomac River with two small boats, and found that at a mile and a quarter, the farthest distance experimented upon, the sound due to the action of the interrupter in one boat was distinctly audible in the other. The experiment did not succeed quite so well in salt water.

Professor Trowbridge then mentioned a method which he had suggested some years ago for telegraphing across the ocean without a cable; the method having been suggested more for its interest, than with any idea of its ever being put in practice. A conductor is supposed to be laid from Labrador to Patagonia, ending in the ocean at those points, and passing through New York, where a dynamo-machine is supposed to be included in the circuit. In Europe a line is to extend from the north of Scotland to the south of Spain, making connections with the ocean at those points: and in this circuit is to be included a telephone. Then any change in the strength of the current in the American line would produce a corresponding change in current in the European line; and thus signals could be transmitted. Mr. Preece, of the English postal telegraph, then gave an account of how such a system had actually been put into practice in telegraphing between the Isle of Wight and Southampton during a suspension in the action of the regular cable communication. The instruments used were a telephone in one circuit, and in the other about twenty-five Leclanché cells and an interrupter. The sound could then be heard distinctly; and so communication was kept up until the cable was again in working-order. Of the two lines used in this case, one extended from the sea at the end of the island near Hurst castle, through the length of the island, and entered the sea again at Rye; while the line on the mainland ran from Hurst castle, where it was connected with the sea, through Southampton to Portsmouth, where it again entered the sea. The distance between the two terminals at Hurst castle was about one mile, while that between the terminals at Portsmouth and Rye amounted to six miles.

A few years ago Mr. E. H. Hall, then a student at the Johns Hopkins university, taking a thin strip of gold-leaf through which a current of electricity was passing, and joining the two terminals of a very sensitive galvanometer to two points in the gold-leaf, one on one edge, and the other on the other, choosing the points so exactly opposite that there was no current through the galvanometer, found that on placing the poles of a powerful electro-magnet, one above and the other below the strip of gold-leaf, he obtained a current through the galvanometer, thus indicating that there was a change in the electric potential, due to the action of the magnet. Mr. Hall explains this change by supposing the rotation of the equipotential lines in the conductor about the lines of magnetic force. This explanation has been brought into question by Mr. Shelford Bidwell, who attempts to explain the action thus: The magnetic force acting on the conductor carrying the current would cause the conductor to be moved sideways, were it free to move; but, since it is held by clamps at the ends, the magnetic force acting upon it brings it into a state of strain, one edge being compressed and the other stretched; and Mr. Bidwell supposes the whole Hall effect to be due to thermal actions taking place in consequence of this unsymmetrical state of strain. Professor Hall, who is now at Harvard, has made some careful experiments to test this explanation of Mr. Bidwell. He used not only gold-leaf, but strips of steel, tinfoil, and other metals, and clamped them sometimes at both ends, sometimes in the middle, and sometimes only at one end; and in all cases the action was the same, with the same metal, irrespective of the manner of clamping. This was strong evidence against Mr. Bidwell's position. Sir William Thomson suggested, as a further test, to bring about the state of strain, which Mr. Bidwell supposes to be the primary cause of the action, by purely mechanical means, bringing pressure to bear on one side or the other, and seeing whether the action obtained is at all commensurate with the action found by Mr. Hall.

Professor Hall then discussed an experiment by which Mr. Bidwell had obtained a reversal of the effect; and showed that the reversal was only apparent, and that when carefully examined the results of Mr. Bidwell's experiment were best satisfied by the theory of the rotation of the equipotential surfaces about the lines of magnetic force. Sir William Thomson spoke of the discovery of Mr. Hall as being the most important made since the time of Faraday. He favored Mr. Hall's explanation; though he considers Mr. Bidwell's suggestion as very important, and thinks that it will very likely be found that both the Hall effect and thermal effects have a common cause, rather than that one is to be taken to explain the other. He showed also that the mathematical examination of the subject indicates three relations to be investigated, — first, the relation of thermal force to the surfaces of equal rate of variation of temperature; second, the relation of electric current to the equipotential surfaces; third, the relation of the thermal flow to isothermal surfaces. The second of these is that investigated by Mr. Hall, who has found that under the conditions mentioned the lines of flow are *not* perpendicular to the equipotential surfaces. There remains, therefore, 'work for two more Halls,' in either proving or disproving the existence of the analogous actions in these other two cases. Sir William Thomson also suggested the following exceedingly interesting mechanical illustration or analogue of Hall's effect. Let us be living upon a table which rotates uniformly forever. A narrow circular canal is upon this table, concentric with the axis of rotation of the table, and nearly

full of water. After a while the water will acquire the same velocity of rotation as the table, and will come to a state of equilibrium. The outer edge of the water in the canal will then stand a little higher than the inner edge. Let us now apply a little *motive* force to the water, and by means of a pump cause it to flow in the canal in the same direction in which the table is already rotating: it is evident that it will stand higher on the outer edge, and lower on the inner edge of the canal, than before. But, should we cause it to flow in the opposite direction to the motion of the table, it will stand lower on the outer edge, and higher on the inner edge, than in its position of equilibrium.

The experiment made by Mr. Shelford Bidwell may also be illustrated by putting a partition in the canal so as to divide it into two circular concentric troughs, and making a little opening in the partition at some point; then taking two points near the opening in the partition, one in one trough and one in the other, if they are very close to the partition, the point in the outer trough will be at a *lower* level than that in the inner one; but if they are not close to the partition, but one is taken close to the outer edge of the outer trough and the other close to the inner edge of the inner trough, then the point in the outer trough will be at a *higher* level than that in the inner trough, though the difference in level will be only about half of what it would have been had there been no partition separating the canal into two troughs. Professor Forbes called attention to the fact that the classification of the metals according to their thermo-electric qualities gives not only exactly the same division into positive and negative, but that the very *order* obtained in that way corresponds to that obtained by classifying according to the Hall effect, except *possibly* in the case of aluminium.

Prof. Silvanus P. Thompson read a paper on the government of dynamo-machines. It is a subject of considerable importance from the practical point of view, and Professor Thompson has given a great deal of thought to it. After reviewing and criticising the methods used by Marcel Desprez and Ayrton and Perry, he proposed a method devised by himself, and which he has successfully employed. It was what he calls a dynamometric method, since it is based on the employment of a transmitting dynamometer as a governor. In this way the governing action is made proportional to the rate of work. Professor Thompson's very simple device is to have resistance-coils so placed in the pulley of the transmitting dynamometer, which is fixed to the shaft, that as the rate of work varies, and the movable pulley of the dynamometer changes its position with reference to the fixed pulley, resistance will be added to or taken from the circuit; thus modifying the current, and bringing about the required government.

An interesting paper was also read by Professor Wead, in which he gave the results of some experiments made on the energy absorbed by organ-pipes in producing sound. Among other things, he showed that reeds are very much more efficient than pipes, giving far louder sound with less expenditure of energy. He also showed that the results of his experiments, on the energy absorbed by pipes of similar shape but different pitch, confirm the practical rule adopted by organ-builders in increasing the proportional diameter of the pipes as the pitch increases, so as to maintain equal loudness. Professor Wead finds, that for a rise in pitch of sixteen semitones, one-half the energy is required in order to give a scale of sensibly equal loudness.

Professor Loudon read a very interesting paper, giving simple geometrical constructions for determining the cardinal points of a thick lens or a system of thick lenses. It is to be hoped that he may publish his paper in full.

Many other papers were read of more or less interest, but those given are the most important.

NOTES AND NEWS.

It may be well to call attention once more to the course of eighteen lectures by Sir William Thomson, on molecular dynamics, at the Johns Hopkins university in October. Professors and students of physics are invited to attend.

— The following persons were elected officers of the American association for the advancement of science for the ensuing year: President, H. A. Newton of New Haven, Conn.; permanent secretary, F. W. Putnam of Cambridge (office, Salem, Mass.); general secretary, Charles Sedgwick Minot of Boston, Mass.; assistant general secretary, Charles C. Abbott of Trenton, N.J.; treasurer, William Lilly of Mauch Chunk. Section A, mathematics and astronomy, J. M. Van Vleck of Middletown, Conn., vice-president; E. W. Hyde of Cincinnati, O., secretary. Section B, physics, C. F. Brackett of Princeton, N.J., vice-president; A. A. Michelson of Cleveland, O., secretary. Section C, chemistry, W. R. Nichols of Boston, Mass., vice-president; F. P. Dunnington, University of Virginia, Va., secretary. Section D, mechanical science, J. Burkitt Webb of Ithaca, N. Y., vice-president; C. J. H. Woodbury of Boston, secretary. Section E, geology and geography, Edward Orton of Columbus, O., vice-president; H. Carvill Lewis of Germantown, Penn., secretary. Section F, biology, Burt G. Wilder of Ithaca, N.Y., vice-president; M. C. Fernald of Orono, Me., secretary. Section G, histology and microscopy, S. H. Gage of Ithaca, N.Y., vice-president; W. H. Walmsley of Philadelphia, Penn., secretary. Section H, anthropology, W. H. Dall of Washington, D.C., vice-president; Erminnie A. Smith of Jersey City, N.J., secretary. Section I, economic science and statistics, Edward Atkinson of Boston, Mass., vice-president; J. W. Chickering of Washington, D.C., secretary.

— The next meeting of the British association will be held at Aberdeen.

— It was suggested by Capt. Bedford Pim, at Philadelphia, that the 1886 meeting of the American association should be held in London. It is understood that there is no constitutional obstacle in the way of the association meeting outside of America; and it